# CogAT®

## Form 6

# A Short Guide for Teachers

## Version 1.1

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# Contents

# PART 1 Basic Information about the *Cognitive Abilities Test™*

## Purpose of the Test

Form 6 of the *Cognitive Abilities Test™ (CogAT®)* appraises the level and pattern of cognitive development of students from kindergarten through grade 12. The test measures both general and specific reasoning abilities. The general reasoning abilities reflect the overall efficiency of cognitive processes and strategies that enable individuals to learn new tasks and solve problems, especially in the absence of direct instruction. These abilities are assessed in three *CogAT* batteries: the Verbal, Quantitative, and Nonverbal batteries. Each is represented by two or three different reasoning tasks. Having *multiple measures* in each domain greatly increases the dependability of the score profile that is reported for each student.

The *Cognitive Abilities Test* measures developed abilities, not innate abilities. The development of these abilities begins at birth and continues through early adulthood. It is influenced by both in-school and out-of-school experiences. Because these abilities are closely related to an individual's success in school in virtually all subjects, test results may be used in planning effective instructional programs. In combination with other relevant information about a student, scores can be used to adapt instruction in ways that enhance the student's chances of success in learning.

## Structure of the Test

Each battery of *CogAT* uses a variety of test tasks; for example, the tasks on the Verbal Battery of Levels A–H include verbal classification, sentence completion, and verbal analogies. These tasks are good measures of abstract reasoning skills and were selected because they are developmentally appropriate for the age and grade levels of the students being tested. Although the same kinds of abstract reasoning skills are tested from kindergarten through grade 12, developmental differences between students in the primary grades and those in grades 3 through 12 require that different types of test tasks be used for each group. In addition, the procedures for administering *CogAT* are different in kindergarten through early grade 3 from those used in grades 3 through 12. To accommodate these developmental differences, *CogAT* has two separate series of tests: a Primary Edition containing Levels K, 1, and 2 and a Multilevel Edition containing Levels A through H.

Levels K through 2 can be used from the beginning of kindergarten through grade 2, although Level 2 can be used in grade 3 for students who are slow in cognitive development. Levels A through H are administered to students from grades 3 through 12. Level A can also be used in grade 2 to appraise students who have a faster rate of cognitive development than their age peers. Successive levels of each test battery were created by dropping the easiest test items and adding an equal number of more difficult items. In this way, the overlapping of test items within the Primary Edition and within the Multilevel Edition allows school personnel to adjust the difficulty level of *CogAT* to a student's rate of cognitive development. Students in the same grade need not all take the same level of the test. This permits the most reliable assessment of the student's cognitive skills to be obtained in any school grade. The complete series provides a continuous scale for appraising cognitive growth and development from the beginning of kindergarten through grade 12.

## Using the Test Results

The three primary uses of *CogAT* scores are (1) to guide efforts to adapt instruction to the needs and abilities of students, (2) to provide an alternative measure of cognitive development, and (3) to identify students whose predicted levels of achievement are markedly discrepant from their observed levels of achievement. A brief discussion of each use follows.

The first and most important use of *CogAT* scores is to help teachers adapt instructional goals, methods, and materials to the individual needs of students. Part 3 explains how to make principled adaptations of instruction and discusses why *CogAT* scores are especially useful for guiding this process. Part 4 offers specific suggestions for building on students' strengths whereas Part 5 contains suggestions for avoiding or strengthening their weaknesses. The interpretation of mixed profiles (a relative strength and a relative weakness) is briefly summarized in Part 6.

The second use of *CogAT* is to provide a measure of each student's level of cognitive development that captures important information not represented in school grades or in other measures of school achievement. For example, *CogAT* scores help identify academically gifted students. Only about half of the students who score in the top 3 percent on the *Iowa Tests of Basic Skills®* also score in the top 3 percent on *CogAT*. This means that *CogAT* will identify many students as academically gifted who would not be identified on the basis of academic achievement alone. Conversely, *CogAT* scores show that most low-achieving students are able to reason at higher levels than their academic performance suggests. In fact, the lower the students' scores on an achievement test, the greater the probability that their *CogAT* scores will be at significantly higher levels. Minority students and English language learners are especially likely to show a significant strength in nonverbal reasoning, particularly on the Primary Edition of *CogAT* used in kindergarten through grade 2. See the section "Encouraging Information for Many Low-Achieving Students" in Part 5 of the *CogAT Form 6 Interpretive Guide for Teachers and Counselors* for more information.

The third use of *CogAT* scores is to identify students whose levels of academic achievement are substantially lower or higher than expected given their *CogAT* scores. Students whose achievement is markedly below expectations should be checked for other problems such as learning disabilities, poor vision or hearing, the need for more assistance in completing school lessons, or the need for a different instructional program. On the other hand, students whose academic performance is better than would be expected from their *CogAT* scores should also be examined. These students have learned well the specific skills taught in school but are less successful in solving unfamiliar problems. Such students might profit from tasks that emphasize transfer and innovation. For more information, see the section "Interpreting Discrepancies between Ability and Achievement" in Part 5 of the *CogAT Form 6 Interpretive Guide for Teachers and Counselors* and the section "Using *CogAT* to Identify Students with Unexpectedly High or Low Levels of Achievement" in Part 2 of the *Interpretive Guide for School Administrators*.

## Types of Norms

Two types of norms, age norms and grade norms, are provided for all levels of *CogAT*. Age norms permit educators to compare one student's performance on the test to that of other students in the same age group. Grade norms permit one student's performance to be compared to that of other students in the same grade group.

**Age Norms.** The age norms for *CogAT* extend from 4 years and 11 months to 18 or more years. When the Riverside Scoring Service® scores *CogAT,* students are grouped by age in one-month intervals from 4 years and 11 months through 18+ years. When tests are hand scored using the *CogAT Form 6 Norms Booklet,* three-month intervals are used.

**Grade Norms.** The grade norms provided for *CogAT* cover the range from kindergarten through grade 12 for three test periods in the school year—fall, midyear, and spring. Although the majority of students in a particular grade fall within a narrow age range, some individuals are much younger or older than the typical student. For example, at the beginning of first grade, the majority of students are likely to range in age from 6 years and 2 months to 7 years; however, there are students in some first-grade classes who are 5 years and 9 months old and some who are 8 years old. When a student's age is typical for the group, the student's age and grade scores will be identical or nearly so. However, if individuals are very young for the grade, their age scores will be higher than their grade scores. If individuals are much older than the typical student in the grade, their grade scores will be higher than their age scores. For individuals who are younger or older than the typical student in a grade, grade norms, rather than age norms, are more appropriate to use when trying to understand the students' academic performance.

**Local Norms.** In some school systems, the characteristics of the student population differ markedly from those of a national sample of school-age children. When national norms are used in these districts, the scores of students on both achievement and ability tests are likely to be skewed toward the high or low extremes of the score distribution. Local norms provide another perspective by comparing the performance of each student to others in the local norm group.

## Types of Scores

The starting point for the construction of all norms is the number of correct answers that students mark on their answer document. The number of correct answers given for a battery is called the *raw score.* A raw score can be converted into a Universal Scale Score. The first step in developing norms for *CogAT* was to construct a Universal Scale Score scale.

**Universal Scale Score (USS).** The *Universal Scale Score* is a normalized standard score that is used as the entry for all of the age and grade norms tables for *CogAT.* The USS provides a continuous growth scale of cognitive development from kindergarten through grade 12. The *CogAT Form 6 Norms Booklet* provides tables for converting the raw score for each battery to a Universal Scale Score. Each of the three USS scores is then used for entry to tables in the *Norms Booklet* that give the following scores for each battery: (1) a Standard Age Score, (2) percentile ranks by age and by grade, and (3) stanines by age and by grade.

To obtain a *Composite,* or total score for all three batteries, the Universal Scale Scores for the three batteries are summed and divided by three. Tables are provided in the *Norms Booklet* for converting this Composite USS to a Standard Age Score, to percentile ranks by age and by grade, and to stanines by age and by grade.

**Standard Age Score (SAS).** The *Standard Age Score* scale is a normalized standard score scale for each battery and the Composite. The SAS has a mean of 100 and a standard deviation of 16. It permits educators to compare the rate and level of cognitive development of an individual to other students in the same age group. For example, students who have an SAS of 100 on the Verbal Battery have a rate and level of development of verbal reasoning skills that is typical of their age group. A student who has an SAS of 125 on the Verbal Battery has a faster rate and a higher level of development of verbal reasoning skills than the typical student in the same age group. The SAS scale provides fine discriminations among high- and low-scoring students.

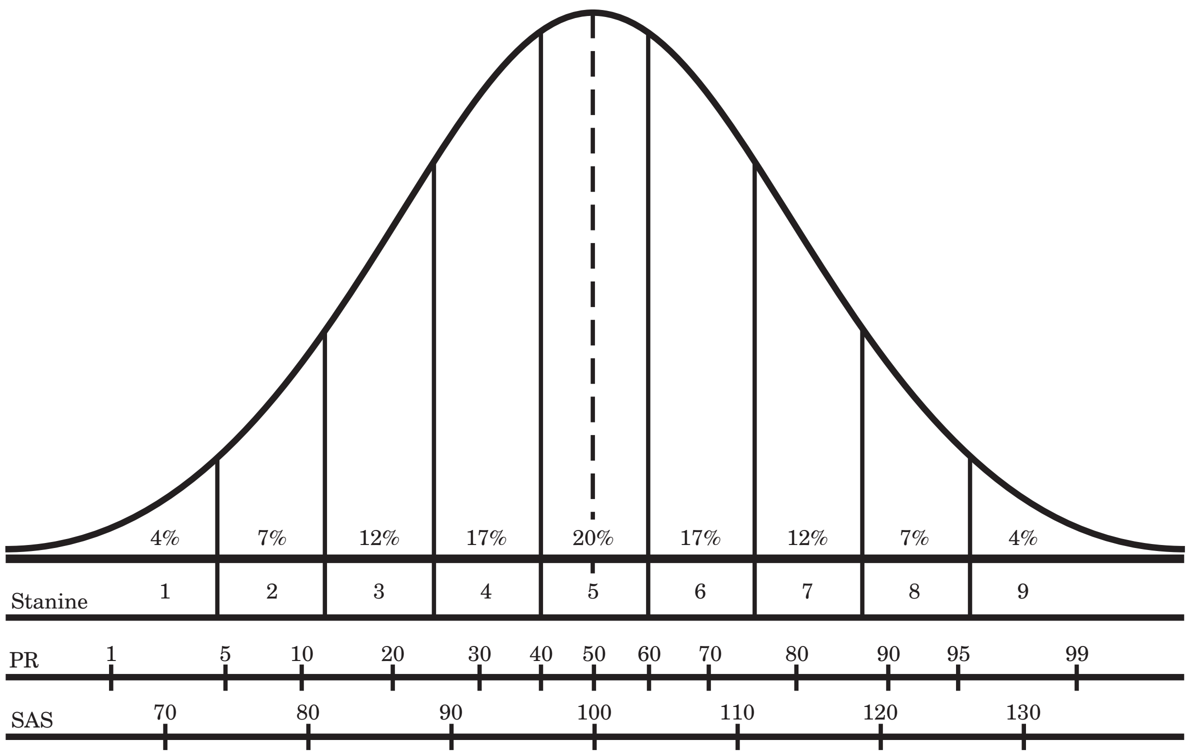
**Percentile Rank (PR).** A *percentile rank* indicates the percentage of students in the same age or grade group whose scores fall below the score obtained by a particular student. For example, if a fifth-grade student obtains a grade PR of 90 on the Quantitative Battery, it means that 90 percent of the fifth-grade students in the standardization sample received

scores lower than the score obtained by this particular student. For *CogAT,* percentile ranks are provided for both age and grade groups. A PR of 50 is considered average for an age or grade group.

**Stanine (S).** The *stanine* scale is a normalized standard score scale consisting of nine broad levels designated by the numbers one through nine. Stanines are provided for both age and grade groups. Stanines, which are similar to percentile ranks, are relatively easy to use because they are all one-digit numbers. The major advantage of stanines is that the broad groupings discourage overinterpretation of small, insignificant differences among test scores.

**Interchangeability of Normative Scores.** SAS scores, percentile ranks, and stanines reported for each battery and the Composite offer three comparable ways of describing an individual's performance on *CogAT* and are interchangeable as Figure 1-1 illustrates.

**Figure 1-1: Relationship of Stanines, Percentile Ranks, and Standard Age Scores**




## Understanding Score Profiles

Since *CogAT's* inception, the authors have encouraged teachers to focus on the student's scores on the three *CogAT* batteries rather than on the student's Composite score. The scores on the three batteries make up a student's *score profile.*

A profile must capture two things. First, it must identify whether some scores are significantly higher or lower than other scores. This is called the *pattern* of scores. Second, it must index the overall height, or *level,* of the scores. The same pattern—say a higher score on the Verbal Battery than on the other two batteries—often has different implications for instruction if the level of scores is low than if it is high.

How can we know if the verbal score is significantly higher than the quantitative score? All test scores have some error of measurement, so the difference should be larger than the error in either score. For most test takers, these errors are about the same size and can be directly estimated from the reliability coefficient. However, Form 6 of *CogAT* goes one step further and estimates the error of measurement anew for each student. This error will be high if the student responds inconsistently to items in the same battery (for example, if the student misses easy items but solves difficult items) or if the student does well on one subtest and poorly on another in the same battery. This means that a low score will *not* be interpreted as a relative deficit just because the student misunderstood one of the subtests or otherwise exhibited confusion in the answers marked.

Using the individual error scores, confidence intervals are drawn around each of the three battery scores. These confidence bands appear on the *List of Student Scores* and on the *Profile Narrative Report*. Based on this information, the score profiles are classified as **A, B, C,** or **E** profiles.

**"A" Profiles.** In an **A** profile, the student's verbal, quantitative, and nonverbal scores are roughly at the s**A**me level. There is only one other piece of information provided by the test, and that is the overall height, or level, of the profile. This type of profile is what we would expect if reasoning ability were a single dimension. It is the pattern assumed whenever a student's ability is summarized in a single score. About one-third of students obtain this profile.

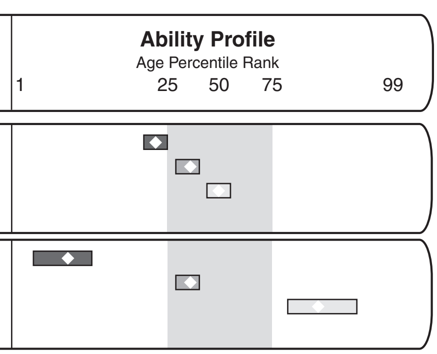
**"B" Profiles.** In a **B** profile, one of the three battery scores is a**B**ove or **B**elow the other two scores. The student shows a relative strength (when one score is above the other two) or a relative weakness (when one score is below the other two). For example, **B (V+)** means that the scores show a **B** profile with a strength in verbal reasoning; **B (N–)** means a relative weakness on the Nonverbal Battery. Overall, approximately 40 percent of students obtain a **B** profile. Thus, **B** profiles are more common than **A** profiles.

**"C" Profiles.** This profile is called **C** for **C**ontrast. The student shows a relative strength *and* a relative weakness. This pattern is much less common. About 14 percent of students have a **C** profile. A student who shows a relative strength on the Verbal Battery and a relative weakness on the Quantitative Battery would have a **C (V+ Q–)** profile.

**"E" Profiles.** The **B** or **C** profile for some students is much more extreme than for others. Figure 1-2 provides two examples. Both students show a significant difference between their verbal and nonverbal reasoning abilities. For the first student, this difference is about 12 points on the SAS scale. For the second student, it is much larger—41 points. We want to call attention to this much larger difference. It surely has greater impact for teaching than the smaller difference.

**Figure 1-2: Three Significant Differences**

| CASE | | AGE SCORES SAS | S | PR |
|---|---|---|---|---|
| I | V | 88 | 3 | 23 |
| | Q | 93 | 4 | 33 |
| | N | 100 | 5 | 50 |
| | Profile 4C (V– N+) | | | |
| II | V | 75 | 2 | 6 |
| | Q | 93 | 4 | 33 |
| | N | 116 | 7 | 84 |
| | Profile 4E (V– N+) | | | |



The authors call any profile in which there is a difference of 24 or more points (on the SAS scale) between two scores an **E,** or **E**xtreme, profile. Approximately 14 percent of students show an **E** profile. In the *CogAT Form 6 Interpretive Guide for Teachers and Counselors,* suggestions for teaching students with **E** profiles are listed with the corresponding **B** or **C** profiles.

**Level of Scores.** Suggestions for teaching depend on both the pattern and the level of the student's scores. The letters **A, B, C,** and **E** say something about the *pattern.* An estimate of the *level* is captured in the number that precedes the letter. This number is the student's middle age stanine. For example, if the student has age stanines of 6, 3, and 8 on the Verbal, Quantitative, and Nonverbal batteries respectively, the student's middle age stanine would be 6. A score profile of **4B (V+)** means that the student's middle age stanine is 4. This is the best estimate of the student's typical level of reasoning ability outside of the verbal domain. It is the baseline against which the verbal strength is measured. Stanines may be grouped as follows:

| | |
|---|---|
| Stanine 9 | Very High |
| Stanines 7–8 | Above Average |
| Stanines 4–6 | Average |
| Stanines 2–3 | Below Average |
| Stanine 1 | Very Low |

In general, the profile number (middle age stanine) carries the most information for **A** profiles, less for **B** profiles (now we must also consider the strength or weakness), still less for **C** profiles, and the *least* information for **E** profiles.

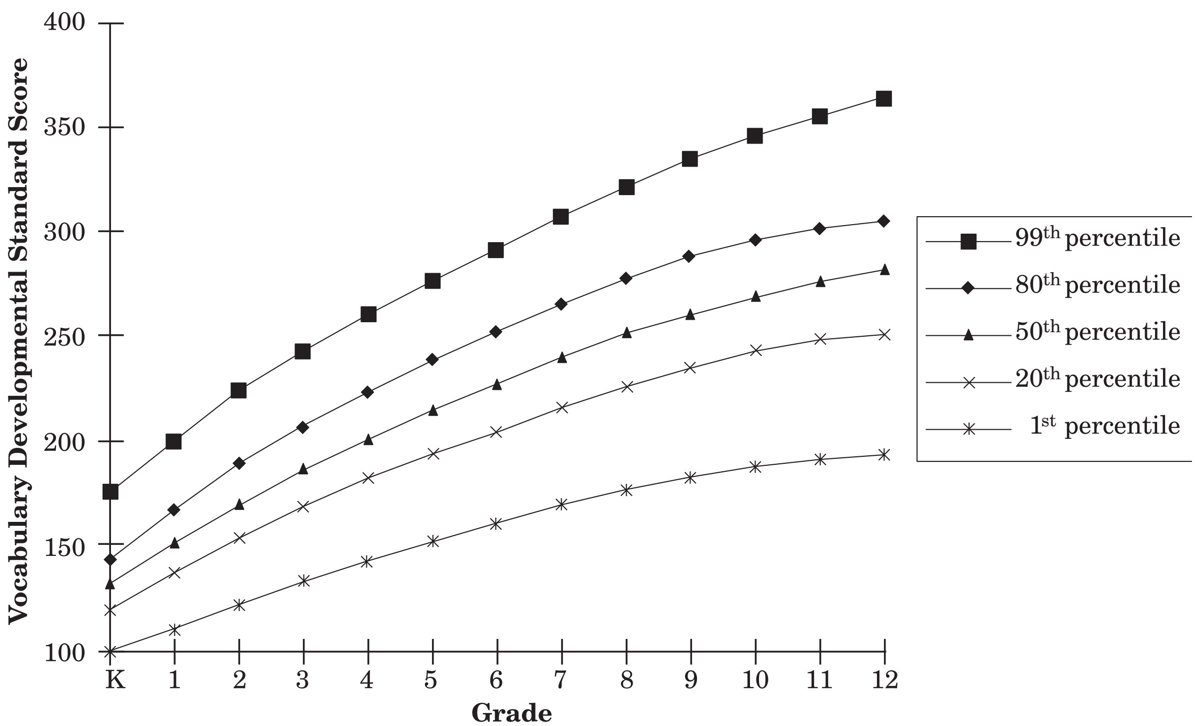
# PART 2 Adapting Instruction to Individual Differences

Adapting instructional methods in order to meet the unique needs of each student has long been a goal of thoughtful teachers. A substantial body of research exists to guide decisions of how best to educate different students. However, very little of this information has found its way into curriculum guides and other materials that teachers use. The following section reviews some of these general principles for adapting instruction to the needs and abilities of students. The section begins with some myths about instructional adaptation.

## Common Myths about Adapting Instruction

**Myth 1: All Students Are Pretty Much Alike.** Although few educators would agree with this statement, it is sometimes asserted that given the same high-quality instruction, all students can achieve the same high standards. Actually, students differ greatly, so teachers must often accommodate a wide range of individual student differences in their classrooms. Figure 2-1 illustrates the differences in students' scores on the Vocabulary test of the *Iowa Tests of Basic Skills*. Individual differences on this test are not particularly special; other tests show the same pattern.

**Figure 2-1: Differences in Students' Scores on the Vocabulary Test of the *Iowa Tests of Basic Skills***



The middle curve in Figure 2-1 illustrates the scores of the typical students in each grade. Growth is rapid during the early school years and then levels off. The remaining curves illustrate the scores of students at other points in the distribution. Thus, the top curve shows the highest scores at each grade ($99^{th}$ percentile), whereas the bottom curve shows the lowest scores ($1^{st}$ percentile). Notice that the variability of scores increases as one moves up the grades. Although kindergartners differ substantially from one another, eighth graders differ even more. Most importantly, notice the relationship between the top curve at the lower grades and the bottom curve at the upper grades. Some first graders score better than many eighth graders. Similarly, some eighth graders do better on these tasks than many high school graduates—indeed, better than some college students.

Not only is the range of individual differences vast, it is also multidimensional. Students who are at the top of the distribution in language skills are unlikely to be at the top in mathematics. Notice too that although grouping students by age reduces the range of individual differences in classes, it by no means eliminates these differences. All of these individual differences have implications for instruction. What is good for the least-able student is not necessarily good for the most-able student or vice versa. What works for the student who reasons well with images but poorly with words is not just as effective for the student with the opposite profile. In sum, there is not one best way to teach science, mathematics, or reading.

**Myth 2: Every Student Is Unique.** The opposite myth—namely, that every student is unique in every way—is also untrue. If each student is unique, then each needs an educational program specifically tailored to her or his needs and abilities.

It is helpful to keep in mind that, in some respects, every student is like *all* other students, like *some* other students, and like *no* other student. Generalizations about teaching and learning are possible only to the extent that the first and second statements hold. If every student is unique in every way, then no generalizations can be offered. A good educational program, then, is faithful to all three aspects—the universality, the commonality, and the uniqueness of each student.

**Myth 3: Adaptations Should Be Based on Learning Styles.** The third myth is that effective instructional adaptations should be based on the profile of each student's specific learning abilities. Educators have probably always had a better sense about this than psychologists. When educators refer to a student's "learning style," they typically imply something about the student's ability to reason in a particular symbol system. Since the work of L. L. Thurstone in the 1930s, however, psychologists have measured specific abilities by making the tests that measured them as independent of each other as possible. Unfortunately, to accomplish this, it was necessary to reduce as much as possible the demands for reasoning. For example, spatial ability was measured by how rapidly test takers could mentally rotate images, not by how well they could reason using visual imagery. When abilities were measured in this way, investigators repeatedly discovered that it did not seem to matter much whether instructional methods matched the profile of each student's abilities. Rather, it was an estimate of the student's reasoning ability that routinely showed interactions with instructional methods (see "Evidence from ATI Research" in Part 5 of the *CogAT Form 6 Interpretive Guide for Teachers and Counselors*).

Self-reports of learning style have not fared much better. Questionnaires that label students as "visualizers" or "verbalizers" or as "auditory learners" or "visual learners" may be helpful in assisting students to understand themselves better, but such measures have not proven useful for helping teachers adapt their teaching methods and materials in ways that help more students succeed. Because of this, the profile of reasoning scores on *CogAT* provides a measure of learning style much closer to the one teachers have wanted, but psychologists have not provided. More importantly, it actually works.

**Myth 4: If the Method Is Right, the Outcome Will Be Good.** Another myth is that if we somehow knew more, we would be able to specify exactly how to arrange conditions to maximize the learning and motivation of every student. This ignores the inherent unpredictability of human behavior. It assumes that behavior can be understood with the same causal models we use for predicting the flight of a golf ball or the reaction of two chemicals. Yet, even physical systems such as the weather can only be described in terms of probabilities. Improvements in our ability to measure winds and moisture and to create ever more sophisticated computer models of the weather will reduce this uncertainty, but they will never eliminate it. Educators are in a similar position when they attempt to apply principles of learning to individual students. Some efforts will fail, but if the research that guides these efforts is solid, educators will, on average, make better decisions than if they had not made the adaptations in instruction.

**Myth 5: Individualization Requires Separate Learning Tasks.** Some early attempts to individualize instruction implied that each student should work on a different task, one uniquely matched to her or his needs. Most of these efforts were based on behavioral theories of learning that viewed development as a ladder with many small steps, each of which needed to be reinforced. In the extreme, students ended up working alone (in cubicles) on workbooks, teaching machines, or, more recently, computers. Teachers were reduced to paper shufflers and monitors, occasionally dispensing instruction but rarely engaging the group as a whole.

We now know better. We know that students learn by observing and interacting with other students and adults. Groups are especially important for learning how to think. We learn to think in new ways by observing others as they solve problems and then verbally or physically reenacting the process ourselves. With practice, what is at first social and external becomes personal and internal.

Development occurs along many dimensions, not just one. Lower-level skills need not always be learned before higher-level skills. Therefore, instead of searching for the one task that uniquely matches the student's needs, educators must more often search for tasks that can simultaneously appeal to students at many different levels. In other words, the goal should be to find broad activities that engage many students at once, rather than to find many narrow tasks that uniquely fit the needs of each student.

What do broad tasks look like? Consider, for example, classic stories. Students of different ages can enjoy the same story because it allows entry at multiple levels. The youngest child may attend only to the pictures and to some of the action. An older child may understand the plot, and the adult who is reading the story may appreciate the broader theme. Different students can meaningfully engage a story at different levels or from different perspectives to learn from it. Thus, adaptation does not mean that students should work alone or even that they should be separated into groups.

## Conceptualizing Persons and Situations

Successful adaptation of instruction requires an understanding of the transactions that occur between students and classroom environments. These transactions depend on the characteristics of the students (such as their abilities) and the characteristics of environments (such as the amount of structure provided). A useful way to think about the interdependence is to consider personal characteristics as *propensities,* or tendencies to act or think in certain ways. For example, some students enjoy competition; they have a propensity to notice, or even to seek out, opportunities to engage in competition. A student who does not enjoy competition may not even be aware of these cues. Environmental cues that link to personal characteristics are sometimes called *affordances.* The idea is that situations differ in the activities they afford people who have different propensities. Classrooms in which desks are arranged in circles afford, that is, make likely, interactions between students. Classrooms in which desks are arranged in rows afford attending to someone at the front of the room.

Instructional environments differ in their demands (what they require of all) and in their affordances (what they make likely or useful). Students also differ in their sensitivity to different affordances. Whether a quiz is perceived as a challenge or as a threat depends in large measure on the propensities or characteristics of the students. In general, however, some students will be more in tune with the demands and affordances of a situation, whereas others will not. For some there will be harmony, for others discord. The key to making effective instructional adaptations is knowing the major dimensions along which these transactions occur. This is where research is most helpful. Of the hundreds of ways in which classrooms differ from one another, a handful of ways have repeatedly emerged as important sources of harmony or discord. Similarly, of the hundreds of ways in which students differ, a few are much more important than others. The section that follows begins first by summarizing characteristics of students and then turns to characteristics of environments.

## Important Characteristics of Learners

Success in school depends on many personal and social factors, but of the many things that could matter, two matter the most: (1) the students' knowledge and skills in a domain and (2) their abilities to reason in the symbol system used to communicate new knowledge in that domain. Furthermore, these are the two abilities that routinely moderate the effectiveness of different instructional methods. *CogAT* measures reasoning abilities, which is why it is so helpful in guiding efforts to adapt instruction. For example, it is not the ability to generate visual images that matters, but the ability to reason with and about those images. Similarly, it is not the ability to remember words or to speak fluently that matters more in some instructional treatments than in others, but rather the ability to reason about the concepts that the words signify.

Although information about reasoning abilities and prior achievement is critical for making instructional adaptations, it is not sufficient. Of the many other differences among individuals that can be measured, several have repeatedly been found to moderate the effectiveness of instructional methods. The first characteristic is *affect:* positive affect as reflected in interest in a topic (which enhances learning) and negative affect as reflected in anxiety (which generally reduces learning). Indeed, anxiety probably moderates the effectiveness of instruction more than any other noncognitive variable.

The second characteristic is *persistence.* Students who lack persistence have not developed the ability to monitor their performance, to keep themselves on task, and to handle intrusive thoughts and emotions. They need support, monitoring, and encouragement if they are to be successful. Similarly, students who are *mindful* or *reflective* learners will generally fare better in a curriculum that encourages discovery than will students who are more impulsive. Although impulsive individuals often prefer activities in which students compete to be first, in the long run they do not fare well in such environments.

These dimensions are aspects of knowing, feeling, and willing. *Knowing* involves knowledge and skill in a domain plus the ability to reason in the symbol system(s) used to communicate new knowledge in that domain. *Feeling* involves interest in the task, which enhances learning especially for students who do not have a positive orientation to their own future. Many such students have anxiety about their performance. This anxiety can impair learning, especially in the case of able students in an unstructured or stressful situation. *Willing* involves both persistence (which enhances learning, especially when working alone or in unstructured situations) and impulsiveness (which impairs learning, especially when working in competitive environments).

## Important Characteristics of Classrooms

The characteristics of learners help determine the types of school environments they perceive. For example, students who are highly anxious will tend to perceive class presentations, tests, and other situations in which they must demonstrate competence quite differently than students who are generally not anxious. In other words, there is no objective way to classify environments. Like beauty, the affordances of a situation are in large measure in the eye of the beholder. Nonetheless, there are a handful of characteristics of classrooms that repeatedly interact with personal characteristics of students. Note that there are many characteristics of classrooms that are important for learning but that are not mentioned in this discussion. The focus here is on those features of instructional methods that affect students differently depending on their abilities and personalities. Of the many characteristics of teaching methods that have been shown to matter, only four are described. Each is linked to particular learner characteristics.

**Structure.** Instructional programs differ in the amount of structure they provide. In general, students who have poorly developed reasoning abilities in a domain do better when the instructional program offers greater structure. More-able students, on the other hand, generally do better with less structure. Put another way, more-able students often do better in discovery-oriented environments; less-able students may flounder in such environments. There are many different ways to offer structure. Some are more beneficial in the long run than others.

Structure is a variable that also describes the way classrooms are organized. In general, more anxious and more impulsive students fare less well in unstructured classrooms than in more orderly and predictable classrooms.

**Novelty/Complexity/Abstractness.** Students with poorly developed reasoning abilities typically do less well when the curriculum consists of tasks that are unfamiliar, complex, or require abstract thinking than when the curriculum consists of more familiar tasks that are less complex and fairly concrete. The corollary is that the development of reasoning abilities requires environments that challenge students with novelty, complexity, and the need for abstraction.

**Dominant Symbol System.** Instructional environments differ in the extent to which they require students to process information in particular ways. The three most important symbol systems demanded in academic learning are verbal, quantitative (or symbolic), and figural (or spatial). One of the most effective ways to adapt instruction is to attend closely to these demands, and, when possible, to allow students to use their better-developed abilities in one symbol system to scaffold (support) learning in another. For example, a student with good verbal reasoning abilities but poor quantitative reasoning abilities can improve the latter by learning to talk about quantitative concepts and relationships.

**Opportunities for Working with Others and for Working Alone.** Classroom environments differ in the extent to which they allow students to work with others or to work by themselves. Students differ in the extent to which they enjoy working with many others and in the extent to which they can do so successfully. Some students prefer either to work with one or two others or to work alone. In general, knowledgeable students who reason well are more likely to succeed in situations that require working alone. A related difference is the degree to which students enjoy cooperative versus competitive environments. Highly competitive individuals may find it difficult to work productively in a group and, when required to do so, may try to dominate the group. Conversely, students who enjoy collaborating with others may find competitions distasteful, even when all competitors perceive that they have an equal chance to win.

## General Principles of Instructional Adaptation

**Build on Strength.** When students are weak in one area but strong in another, should we try to strengthen the weaker area or, instead, to build on the strength? The general rule is to build on strength. Students are better able to process information more elaborately and at higher levels when tasks emphasize the type of thinking they do best. However, there are two cautions. First, instruction must challenge students to go beyond the information given, not merely to register it. This means that instruction geared to their strength must challenge that strength. Second, students must often learn to perform tasks that they do not do well. In such cases, instruction should still aim to build on strength by emphasizing aspects of tasks that avoid their weakness until the students have established a foothold. For example, consider students who have difficulty learning computation skills but who show strength in verbal reasoning. Using group oral recitation would emphasize their verbal strength more than silent practice on a computer. Therefore, the recommendation would be to start with oral recitation and transition to computer practice after oral practice has been successful.

**Focus on Working Memory.** One of the most pervasive findings in all research on instruction is that more-able students do better when instruction allows them to do things in their own way. Conversely, less-able students do better when given greater instructional support. Instruction that scaffolds (supports), sequences, and otherwise reduces the burden of information processing, generally helps less-able students. The critical factor here is the burden placed on working memory. When helping less-able students, the key is not so much to reduce the need for thinking as it is to reduce the burden on working memory.

Students generally fail if tasks exceed their attentional capacity. This happens when they try to remember and do more things than they are capable of remembering and doing at one time. In cognitive terms, their working memory is overloaded.

Working memory has three aspects: (1) information storage, (2) information processing, and (3) monitoring/executive functions. Information storage is basically how much "stuff" a person can keep in mind at one time. It is a function of an individual's familiarity with the material, the strategies used to remember it, and the general facility in creating and retaining the type of memory code that best represents the information. People differ in the ease with which they can encode and transform visual images, sequences of sounds, numbers, and other symbols.

When we measure working memory, we do not simply ask people to remember something. Rather, we require that they remember something while transforming it into something else. This requires storing, processing, and managing the tradeoff between the two. Thus, both transformation and self-monitoring processes are also important aspects of working memory. Self-monitoring has several aspects. Most importantly, it means keeping track of what one is doing and what one has already done. This helps the individual avoid doing the same thing twice. It also means comparing performance with a goal or a standard.

Effective use of working memory resources is critical for successful reasoning. Students cannot make inferences about how two or more ideas are connected if they cannot hold the ideas in mind. Nor can students compare goals with outcomes, revise strategies to accommodate feedback, or engage in any of a hundred other forms of critical thinking and reasoning if working memory resources are inadequate. Two of the most important questions for educators to ask regarding their students then, are "What are the major demands that this activity places on the students' working memory?" and "Which of these processes, or memory requirements, can be offloaded, or scaffolded?"

**Scaffold Wisely.** Whenever students try to solve problems, there are many processes that must be executed simultaneously in working memory. *Scaffolding wisely* means offloading, at least for the moment, those memory requirements and processes that are not the object of the instructional activity. For example, the demands of spelling and grammar can easily

overwhelm the working memory resources of a beginning writer. Offloading these processes temporarily frees the student to construct a connected narrative. Similarly, one of the last steps in the acquisition of skills is learning to monitor one's own performance. Especially in the early stages of skill acquisition, monitoring functions can be offloaded to another individual by having students work in pairs. Writing things down, drawing pictures, and practicing a skill until it can be performed automatically also reduces demands on working memory.

Historically, one of the most common accommodations for students who had difficulty making inferences, deductions, and elaborations was to offload the reasoning requirements of tasks. This works well in the short run but leaves students increasingly unprepared to face the challenges of school learning. Therefore, when reasoning is an essential part of the task, endeavor to offload reasoning last.

**Emphasize Strategies.** Psychologists who study reasoning distinguish between tacit and intentional reasoning processes. *Tacit processes* occur outside of awareness. They typically do not require much attention and are performed quickly and intuitively. *Intentional processes,* on the other hand, require conscious awareness. Intentional thinking is often described as effortful and rule-based. Such reasoning processes are made more broadly useful when students learn to use them strategically. At the lowest level, this means simply having a strategy that one can consciously use when necessary. At intermediate levels, it means having multiple strategies available for possible use. At a more advanced level, it means knowing under what circumstances each strategy is best used. At the highest level, it means becoming strategic and reflective in one's thinking. Instructional adaptations are most effective over the long haul if they help learners become more intentional and self-regulated in their learning. Encouraging students to use and monitor the effectiveness of different strategies helps them better use their cognitive and affective strengths and avoid, or scaffold, their weaknesses.

**When Grouping, Aim for Diversity.** The *CogAT* authors do *not* recommend that the test results be used to routinely group students by score levels or by score profiles. Students are most likely to improve their ability in a domain if they have the benefit of learning from classmates whose skills and approaches to problems differ from theirs. This is particularly important for students who have a marked deficit in one area. Improvement is more likely if such students have high-quality interactions with individuals who have a relative strength in the same area than if they are constantly paired with other students who, like themselves, have difficulty in that domain. More-able students benefit from such groups to the extent that they are asked to provide explanations and assistance. Highly gifted students, however, can benefit from groups that are more homogeneous in ability but diverse in the range of perspectives offered by participants.

# PART 3 Working with Students of Different Ability Levels

There is both unity and diversity in cognitive abilities. Unity is reflected in the substantial correlation between measures of verbal, quantitative, and figural reasoning abilities. Students who are above average in one domain are likely to be above average in the other two domains. Cognitively, it means that reasoning tasks share common attention, memory, and other processing resources. On *CogAT,* unity is estimated by the overall height, or *level,* of the score profile. This is captured by the median age stanine.

Diversity of abilities is reflected in the fact that although tests of verbal, quantitative, and figural reasoning are correlated, these correlations are much lower than the reliabilities of the three reasoning tests. Cognitively, it means that students differ in their abilities to reason with verbal, quantitative, and figural symbols. On *CogAT,* diversity is reflected in the *pattern* of the scores on the Verbal, Quantitative, and Nonverbal batteries.

When designing effective instruction for a student, one must take into account both the overall level of the three battery scores as well as the pattern of the three scores. In Part 3, we consider differences in the overall level of the profile. These differences are divided into four groups based on the median, or middle, age stanine:

| | |
|---|---|
| Stanines 1–3 | Below Average |
| Stanines 4–6 | Average |
| Stanines 7–8 | Above Average |
| Stanine 9 | Very High |

Parts 4 and 5 consider some of the major differences in the pattern of scores. Part 4 discusses how to capitalize on relative strengths in reasoning abilities. Part 5 considers the opposite problem of shoring up specific weaknesses.

## Instructional Suggestions for Students with Poorly Developed Reasoning Abilities (Stanines 1–3)

Students with poorly developed reasoning abilities often have difficulty learning abstract concepts. Few have effective strategies for learning and remembering. Therefore, they tend to approach learning tasks in a trial-and-error fashion. They typically do not spend much time planning before attempting to solve a problem. As a result, they frequently do not transfer knowledge and skills learned in one context to another context unless prompted to do so. Such students have difficulty detecting relationships, similarities, and differences that go beyond appearances and are easily distracted by salient but irrelevant details in problems.

**Build on Strength.** When working with these students, look for strengths in terms of specific interests and achievements. Even more than other students, those who are behind their peers in reasoning abilities will often learn more and sustain their efforts longer if the teacher discovers and builds on their interests. This is not always possible, nor is it even desirable that all learning be bent to suit a student's interests; but to the extent that it can be done, it will lead to greater effort and a generally more sophisticated outcome.

In addition to their interests, these students often have other competencies that can be emphasized, especially when working in groups. Using these skills helps legitimize the

students' participation in the group. Students who feel that they are participants (rather than observers) have higher levels of motivation and engagement in a task. For example, such students may be able to help draw a poster that summarizes the group's discussion, or to take the lead role in a demonstration.

**Focus on Working Memory.** Attending carefully to the demands placed on working memory can reap great benefits for students with poor reasoning skills. These students are commonly required to do more things at one time than they can do. Learning may start out meaningful, but soon it degenerates into an anxious search for surface features of tasks that suggest a solution. Since the primary burden on working memory comes from the concepts, images, sound sequences, and sentences that must be held in mind, the most effective way to improve performance is to reduce the number of things that must be held simultaneously in working memory. For example, some students will have difficulty coordinating what they hear with what they see or what is on the board with what is on the paper in front of them. Eliminating the need to remember ideas—even temporarily—can greatly assist these students.

Working-memory burdens can also be reduced by using familiar concepts; by making concrete analogies to familiar physical systems; by automatizing skills (such as writing, typing, or calculating); and by offloading items to be remembered or processes that must be performed simultaneously.

**Scaffold Wisely.** Good reasoners engage in what psychologist Robert Sternberg calls *selective encoding.* This means that they know what to attend to and what to ignore when trying to understand a problem. Students with poorly developed reasoning abilities often have difficulty identifying what is important to learn and judging where they should focus their attention in a learning situation. Therefore, they need very specific directions before they start a task or start to study. The use of attention-getting directions can help such students focus on the important aspects of a task, particularly in reading.

Typically, students with poorly developed reasoning abilities learn more effectively in structured learning environments that make fewer demands on their cognitive resources and provide more direct guidance, coaching, and support. Such students also tend to process information slowly and to need a slower pace of instruction than students with average scores on *CogAT* (stanines 4–6). Instructional strategies that use teacher or peer modeling; concrete representations of abstract concepts; demonstrations; pictures; or other types of illustrations, films, videotapes, and hands-on activities are likely to be more effective than verbal explanations. "Doing" is preferred to talking about doing.

A critical issue for instructional programming for these students is the tradeoff between short-term gains and the development of long-term competence. Highly structured environments that remove the information-processing burden from the learner almost invariably result in higher immediate achievement for such students. When offloading processing burdens, however, there is a tendency to dispense with higher-order reasoning processes and retain lower-order memory and skill-execution processes. However, reducing the opportunities to develop reasoning abilities can leave the student even less prepared to cope with novelty on the next occasion. Therefore, to the extent possible, instruction should scaffold lower-order processes and memory burdens and should encourage the development of reasoning and meaning-making abilities for these students.

**Encourage Strategic Thinking.** A few good rules that help students to be more reflective in their learning are more helpful than a detailed list of particular strategies. Planning and practicing when to apply a rule is as important as learning to apply the rule in one context. Since these students often have considerable difficulty identifying appropriate situations in which a particular strategy should be used, the teaching of learning strategies is likely to be much more effective if it is done by modeling and demonstration in the context of ongoing learning situations in the classroom. More-able peers can sometimes provide the guidance these students need in order to focus on relevant aspects of a task, to keep track of what they are doing, and to avoid practicing errors.

Students who struggle to keep up often automatize procedures that get them through a task but that are not generally useful. It is critical, therefore, that students who have difficulty monitoring themselves and who are prone to making errors be carefully monitored during the early phases of skill acquisition to ensure that they have understood the procedure or strategy and are applying it correctly.

**When Grouping, Aim for Diversity.** Students who have difficulty reasoning when alone typically learn more effectively and have higher levels of achievement when they have many opportunities to interact with more-able peers. Students with median stanine scores of 1 to 3 should not be segregated in classes or groups consisting solely of low-scoring students. Participation in activities of all sorts, however, can occur at many levels. Students who have not yet learned how to participate fully in an activity can learn much by observing, listening, and doing what they can.

## Instructional Suggestions for Students with Average Levels of Reasoning Abilities (Stanines 4–6)

**Build on Strength.** Although these students have good resources for learning, they often have difficulty applying what they know when learning a new task, particularly when the task looks different from one they had previously learned. Help them develop the habit of analyzing new tasks to detect relationships with tasks previously learned. Do this by modeling the process for them. These students' strengths will primarily be evident in their interests and, to a lesser extent, in their levels of achievement in different domains. Strive to find ways to encourage the particular academic accomplishments of these students. Finding and nourishing the islands of excellence in all students' schoolwork spreads encouragement.

**Focus on Working Memory.** Students with average reasoning abilities are frequently working at the limits of their attentional resources. Changes in instructional methods or learning strategies that reduce the burden on working memory can have a significant impact on their success in learning. Often working-memory burdens can be reduced by fairly simple modifications of instructional methods, such as putting all the needed information on a single sheet of paper; using familiar, concrete concepts rather than unfamiliar, abstract symbols; and overlearning skills that assist in problem solving and comprehension. Self-monitoring skills are especially troublesome for such students, particularly in the primary grades. Offloading monitoring to another individual by having students work in pairs can be especially effective early in the process of acquiring a new skill or strategy. Also, keep in mind that working-memory burdens will change dramatically as these students gain proficiency with a skill. What is initially overwhelming can, with practice, be well within a student's range.

**Encourage Strategic Thinking.** Memory burdens can also be reduced and thinking made more systematic and successful if students learn to be more strategic and less algorithmic in their thinking. Since they often make errors in implementing learning strategies, these students need frequent monitoring when they are learning a new strategy so that their errors can be corrected. Modeling correct implementation of a strategy is likely to be more effective than simply providing a verbal explanation of it. Students with these score levels benefit from direct instruction in study skills such as note taking, outlining, diagramming, planning use of time, and formulating questions to guide their study. They also need help to learn how to break up complex problems into simpler units and how to keep track of their progress in solving complex problems. The goal is to help students become mindful of their own strengths and weaknesses and of the effectiveness of different strategies in different contexts.

**Scaffold Wisely.** Students with all average scores tend to learn more effectively in school environments that are somewhat, but not highly, structured. These students tend to learn best when instruction is moderately paced and when there is frequent monitoring and feedback on their progress. The goal of good instruction is to provide students with enough support in the form of strategies, memory prompts, and task structure that they can infer, deduce, connect, and elaborate—in short, understand and think for themselves.

**When Grouping, Aim for Diversity.** Students typically learn how to think in new ways by first enacting skills externally. Only after much overt practice can a skill be executed covertly, that is, cognitively. Many cognitive skills seem to be acquired first by observing other students modeling an interaction and then by gradually learning to participate in the same sort of exchanges. Encourage this by structuring groups so that higher-order skills are modeled and then practiced in student conversations. Since research shows that students with average abilities are often left out of group problem-solving efforts, try to structure group interactions so that all students have an equal opportunity to participate.

## Instructional Suggestions for Students with Above-Average Levels of Reasoning Abilities (Stanines 7–8)

**Build on Strength.** These students generally profit most when allowed to discover relationships themselves. Guided discovery methods work better than more structured teaching methods. These students need to be challenged with materials, projects, and problems that are somewhat more difficult than those used for the typical student. Improve their reasoning skills by encouraging them to find modes of communication that most precisely describe the relationships among concepts or the rules that sequence them. For example, in writing, encourage students to find words that express ideas exactly rather than approximately. Encourage these students to follow their interests, and reward perseverance on long-term projects.

**Focus on Working Memory.** Although these students need less practice than average students to master new skills, they acquire complex skills more readily if self-monitoring processes are temporarily offloaded to another student or to a teacher. Enhance working-memory resources dramatically by automatizing low-level skills. This is often best accomplished through focused practice on particular skills. Teach students how to monitor their own thinking and problem solving by recording their thoughts on paper. Show them how carefully studying the written record allows them to revise and clarify their thinking in a way that is impossible when thinking is limited to that portion of an idea sequence illuminated in working memory.

**Encourage Strategic Thinking.** Able students are quick to acquire different learning strategies. Exposure to alternative strategies—especially if modeled by respected adolescents or adults—can help students appreciate the value of different strategies for different persons and problems. Encourage students to try each modeled strategy and help them keep track of the results. As students progress beyond middle school, encourage them to expect changes in strategies that work best for learning.

**When Grouping, Aim for Diversity.** Above-average students are generally excellent group participants, especially if the group is structured so that no one can dominate the discussion or be left out of it. These students can learn well in groups by explaining, by helping to summarize discussions, and by modeling higher-order thinking skills for other students.

## Instructional Suggestions for Very Able Students (Stanine 9)

**Build on Strength.** Students who reason exceptionally well benefit most from discovery learning and least from highly structured learning environments. Good discovery learning need not be a solitary task. All students learn most when in the company of other learners who model new ways of understanding a problem and who challenge the learner to improve her or his current understanding.

The single greatest need of very able students is for academic challenge at a level commensurate with their abilities and achievements. Sometimes this can be accomplished by the careful selection of challenging instructional materials, special projects, or other enrichment activities; but it often requires instruction, particularly in mathematics, at a level several years in advance of that received by age mates.

**Emphasize Strategies.** Very able students are generally receptive to activities that allow them to discover how they can best use their cognitive resources. For students in the early primary grades, this can mean learning not only that there are different ways to attain competence in performing a skill, memorizing poetry, or solving problems, but also that learners have the option of discovering which methods work best for them. For older students, place emphasis on developing thinking dispositions such as reflectiveness and the willingness to (1) shift perspectives and consider alternative opinions and evidence, (2) decontextualize problems, and (3) entertain increasingly sophisticated theories of what counts as knowledge and evidence.

**Scaffold Wisely.** Very able students need access to instruction that allows and encourages them to develop their academic skills. Some also need help in coping with negative affect, such as anxiety. Learning to persist in the face of difficulty can also be an important affective or motivational issue for very able students. Working with an older and more experienced student (or adult) can be especially beneficial.

**When Grouping, Aim for Diversity.** Very able students can benefit from group interactions when they are able to explain difficult concepts to other students, but they learn more when they are able to participate as learners as well. Thus, when grouping very able students with other students, try to devise groups in which they will be learners—not just explainers—and in which there will be a diversity of perspectives among participants.

# PART 4 Building on Strengths

Successful instruction invariably builds on students' strengths. Approximately half of the students who take *CogAT* show an uneven pattern of scores in which the score for one battery is above or below the scores for the other two batteries, which do not differ from each other. Profiles that show a relative strength are more common for low scores (median age stanines of 1, 2, or 3) than for high scores (median age stanines of 7, 8, or 9).

Only general suggestions are offered here. For information on the instructional implications of specific score profiles, see Part 7 of the *CogAT Form 6 Interpretive Guide for Teachers and Counselors* or the Interactive Profile Interpretation System at www.cogat.com.

## A Relative Strength in Verbal Reasoning (V+)

Students with a verbal strength on *CogAT* typically obtain higher than expected achievement test scores in all areas except math computation. The differences are smallest at the primary level and largest at the secondary level. This is in part because verbal reasoning abilities are critically important for success in school and in part because achievement tests present problems verbally and generally require verbal or verbally mediated responses.

Students who show a relative strength in verbal reasoning generally do best when they are encouraged to talk and to write about whatever it is that they are attempting to learn. Some need greater challenges in reading, writing, and speaking than in other areas of the curriculum. At the elementary level, this may mean special reading or writing assignments that are more demanding than the assignments given to other students. If scores on the Verbal Battery are particularly high (stanine 8 or 9), for secondary-level students it may mean placement in honors or advanced-placement classes. Individuals who excel in verbal processing often have remarkably good memories for arbitrary sequences of sounds, letters, words, and events. Indeed, one of the hallmarks of superior verbal ability is memory for order in arbitrarily ordered sequences of letters and sounds. Some cognitive psychologists even posit a special type of memory representation to encode such information. Although such abilities differ from verbal reasoning ability, the two are correlated. Thus, students who excel in verbal reasoning typically are above average in spelling; in their knowledge of syntax and grammar; in their ability to learn other languages; and in their ability to remember dialog, prose, and poetry.

In other curricular areas—particularly in mathematics—encourage these students to use their superior verbal reasoning skills to achieve at higher levels. For example, students with a relative strength in verbal reasoning will often learn best if encouraged to reformulate mathematical expressions verbally and to explain them to others. There is an important pitfall in mathematics, though, in that students with relatively strong verbal abilities often find it easier to memorize formulae than to build more abstract, often spatial mental models of the same conceptual systems. Yet, it is the latter that leads to long-term retention of mathematical concepts, and, more importantly, to the ability to transfer mathematical knowledge to unfamiliar domains. Memorization is often inadvertently encouraged by mastery-oriented teaching methods that reward near rather than far transfer. Therefore, take steps to discourage students who have a relative strength in verbal ability from simply memorizing formulae. The use of computers with sophisticated graphing capabilities can help in this respect. Most importantly, use learning materials and test problems that encourage transfer and that allow these students to use their excellent verbal reasoning skills instead of their excellent rote memories when learning mathematics.

Especially at the primary and early elementary levels, encourage these students to practice math facts orally rather than silently. It is sometimes helpful to consider how one best learns common replies to questions posed in a foreign language and to use similar methods here. Whatever methods are used, expect that these students will need more practice for mastering mathematical skills than they need for mastering reading and language skills.

These students sometimes have difficulty creating a visual mental model of the scenes depicted in a story. Their comprehension will be higher if the text contains illustrations and they are encouraged to make explicit connections between the text and the illustration.

Illustrations are often not needed if students are able to read and write about events that occur in locations that they know well. To encourage the habit of creating a mental model and coordinating it with a verbal description, read aloud to such students pausing frequently to respond to their questions or to ask what they envision. For young children or for those who still have difficulties understanding stories, allow them to make a model of the situation described in the story and then to alter the model as changes occur in the text. The goal is for them to learn how to create a visual mental model that allows them to keep track of the persons and events described in the text.

## A Relative Strength in Quantitative Reasoning (Q+)

Primary-level students who obtain this profile tend to score somewhat higher than expected (on the basis of their verbal and nonverbal reasoning abilities) on both the mathematics and language subtests of the *ITBS®*. By the elementary years, however, the advantage is confined to mathematics and persists through the high school years.

The more pervasive impact of a strength in quantitative reasoning at the primary level in part reflects subtle differences in the constructs measured by the orally administered Primary Edition of *CogAT* and the paper-and-pencil Multilevel Edition of *CogAT*. It also reflects the importance of the ability to engage in abstract thinking in school in the early years. At lower ability levels, a quantitative strength tends to be most apparent in the acquisition of the computational or syntactic aspects of mathematics rather than the conceptual or semantic aspects. Therefore, in building on these students' strengths, instruction should capitalize on their ability to automatize skills. There is some indication at average score levels—and stronger evidence at the higher score levels—of a link between computation skills and grammar and spelling skills.

As with other students who show a particular cognitive strength, the twin goals for these students are (1) to encourage the continued development of their strength and (2) to try to use the strength and information processing skills that it requires to enhance development in other domains. All students, but especially those who generally do not excel in school, need to feel that they can do well at something that is valued by others. A strength—especially an extreme strength—in quantitative reasoning can be a source of great pride. It can provide a way for the student to contribute at high levels to group projects. It can also provide an avenue for building better verbal and spatial reasoning abilities. The connection between a strength in quantitative reasoning and in grammar provides one interesting avenue. Students who excel in learning rule-based mathematical knowledge often show better than expected knowledge of grammar. This strength can be praised and used when asking students to give feedback on each other's writing. This, in turn, can be an entrée for helping these students acquire knowledge of higher-level writing skills (e.g., principles of style or organization). Students who excel in quantitative reasoning often learn computer skills more readily than their peers, especially skills such as procedures for using text editors, spreadsheets, etc. They do not typically excel at computer programming unless their quantitative reasoning abilities are quite high. Students who display high levels of quantitative reasoning abilities typically excel in extracting regularities from their experiences and then reasoning with these abstractions. Encourage development of these abilities through mathematical tasks, games, and puzzles that can be engaged in cooperatively rather than competitively.

Whenever a student displays a particular cognitive strength, education should aim to build on that strength. Students with a relative strength in quantitative reasoning should be encouraged to exploit and further develop this ability. If quantitative reasoning scores are very high, this may mean acceleration for some students; for others, enrichment activities such as math clubs or honors classes will be beneficial. Choosing among these alternatives requires knowledge of the student's level of achievement in mathematics and of affective factors such as anxiety about working with older students.

## A Relative Strength in Nonverbal Reasoning (N+)

Students who show a relative strength on the Nonverbal Battery can be either very good at reasoning with spatial stimuli or particularly adept at solving novel problems that are unlike those encountered in school. Choosing between these explanations often requires outside information. Clues are offered by the presence of difficulties in verbal fluency (as when writing under time pressure or speaking extemporaneously) or difficulties in remembering sequences of words or letters (as in spelling). Students with particularly strong spatial abilities often experience these difficulties. On the other hand, students with strong spatial abilities often excel in drawing, sculpting, and other visual and mechanical arts.

Another possibility is that the profile represents not so much a strength in spatial reasoning as a weakness in both verbal and quantitative reasoning abilities. The latter abilities are developed through participation in activities both in and out of school. Students who, for whatever reason, have not been engaged in the educational process or whose home environment has not encouraged the development of verbal and quantitative abilities can show this pattern of a relative strength in nonverbal reasoning. These students need intensive involvement in activities both in and out of school that will develop their verbal and quantitative reasoning abilities. For suggestions, see the entries in Part 5 for shoring up weaknesses in verbal and quantitative reasoning. The suggestions offered in this section are based on the first interpretation, i.e., that the **N+** profile represents a strength in spatial thinking.

Paradoxically, students who have a relative strength on the Nonverbal Battery tend to obtain lower scores on some subtests of the *Iowa Tests of Basic Skills*® and the *Iowa Tests of Educational Development*® than students with the same levels of verbal and quantitative abilities but an **N–** profile. One explanation for the fact that spatial reasoning abilities are generally irrelevant and sometimes detrimental to success on achievement tests is that schools do not capitalize on students' spatial reasoning abilities. Further, achievement tests—with the exception of the *ITBS* Maps and Diagrams test—generally do not measure spatial modes of thinking. A strength in and preference for spatial modes of thinking runs counter to the predominantly linear and verbal modes of thinking required by conventional schooling. While much effort is directed toward the development of students' verbal and, to a lesser extent, quantitative reasoning abilities, very little effort is made to develop their spatial reasoning abilities. Yet, these abilities have routinely been found to play an important role in high-level learning and in creative contributions in mathematics, science, engineering, and the visual arts. Like verbal and quantitative reasoning abilities, spatial reasoning abilities respond to instruction.

Students with a nonverbal strength tend to exhibit a preference for visual mental models when solving problems. They respond well to texts that contain difficult graphics and prefer maps to verbal directions. At younger ages, these students will learn most readily when the concepts described in textbooks and other media have previously been experienced concretely and can subsequently be applied concretely. Students with a nonverbal strength often perform less well on tasks that require verbal fluency, such as speaking and writing. Indeed, extremely high levels of spatial ability are associated with a diverse array of specific verbal problems such as stuttering, difficulty learning phonics, poor spelling, and difficulty speaking foreign languages.

Learning is easiest for these students when they can readily connect each new concept or relationship with a mental or physical model (e.g., a schematic drawing) of the situation. For young children, comprehension will improve markedly when the text contains detailed illustrations. The tendency to rely on pictures and illustrations resurfaces anytime the student cannot readily envision a mental model of the situation described or the problem presented. This commonly occurs when material is presented verbally at a rapid or inflexible rate (as, for example, on a video presentation). Allowing the student to control the rate at which verbal information is presented by a mechanical device will be helpful. It also occurs when the student has no clear mental model of the situation. In all areas of the curriculum, but especially in science and mathematics, metaphors and analogies that allow students to connect unfamiliar, abstract concepts to a more familiar physical system will not only enable students to understand but will also greatly facilitate retention and transfer.

Students who have relatively strong spatial reasoning abilities will especially benefit from strategies that help them create (1) drawings when solving problems in mathematics, (2) concept maps when taking notes, or (3) mental models of a scene when reading a text. For young children especially, this can be encouraged by asking the children, “What do you see?” Older students can be asked to illustrate the scene—perhaps using computer images or cutout figures. When teaching writing, encourage these students to try descriptive rather than narrative prose. Help them to spend some time first envisioning the scene they would like to describe before they attempt to describe it for someone else. Giving them examples of good descriptive prose is also helpful.

Finally, it is important to encourage the continued development of these students’ spatial reasoning and thinking abilities. These students are often quite skilled in the visual arts, in trades such as carpentry, landscaping, interior decorating, product design, and computer graphics.

# PART 5 Shoring Up Weaknesses

Whenever a student displays a significantly lower score on one of the three *CogAT* batteries, a judgment must be made about the probable cause of the lower score. For most students, it stems from a preference for thinking in one symbol system rather than another.

Only general suggestions are offered here. For information on the instructional implications of specific score profiles, see Part 7 of the *CogAT Form 6 Interpretive Guide for Teachers and Counselors* or the Interactive Profile Interpretation System at www.cogat.com.

## A Relative Weakness in Verbal Reasoning (V–)

Some individuals prefer to think in visual modes and some in symbolic or quantitative modes. These individuals often find it difficult to translate their thoughts into words. Over time, this propensity causes them to lag in the development of verbal abilities of all sorts, including the ability to reason with words. Verbal skills are so critically important for school learning, however, that even these students need to be encouraged to use and develop their speaking, reading, and listening abilities. Nevertheless, students should always be allowed opportunities to build on their strengths. Activities that are unnecessarily verbal can thwart their performance even in domains in which they excel. Common sources of difficulty are (1) directions that are overly long and (2) the requirement that all learning be displayed on tests that necessitate the translation of verbal prompts and the production of verbal responses.

Students with lower verbal scores (stanines 1–4) often find themselves overwhelmed in the classroom, especially when following directions for the first time or when attempting to transfer their attention between different verbal activities. For example, this can occur when students are required to attend to a rapidly paced video presentation and take notes at the same time. Reducing the demands placed on verbal working memory will generally improve performance and reduce frustration.

When teaching strategies to these students, do not expect them to keep in mind a verbal statement and apply it at the same time. Reduce memory burdens by allowing the student to use a prompt, such as a written statement of the strategy. Allow many opportunities to practice the strategy in diverse contexts. Offload monitoring to another student by having students work in pairs. Also, expect that students at lower stanine levels will need explicit discussion of the conditions that should cue possible use of the strategy. Then try to arrange for such conditions to occur unpredictably. The goal is usually not for students to acquire fixed procedures for accomplishing tasks, but for them to learn to call up and use different procedures as circumstances demand.

Although the general principle to "build on strength" still holds, the critical importance of verbal reasoning abilities for success in school requires that relatively more effort be expended improving these abilities than would be expended to improve a relative weakness in quantitative, or especially, nonverbal reasoning. Students who exhibit relatively poor verbal skills often do so because they do not routinely participate in conversations that employ formal language structures and modes of discourse. Improving their verbal reasoning abilities requires exposure to individuals who model hoped-for styles of verbal discourse and verbal reasoning as well as opportunities to engage in conversations in which they practice these speech patterns.

A language curriculum that combines reading, writing, and speaking as well as providing opportunities to practice and receive feedback on each will be more successful than one that has a narrower focus. Keep in mind that at all levels, language and language-mediated modes of reasoning begin with the oral and external; only after much practice do they become subvocal and internal. Further, students can begin to acquire unfamiliar ways of conversing and writing by spending some time imitating the speaking and writing styles of individuals whom they admire. Drama, poetry, and storytelling are particularly useful in this regard. After the language forms and syntax structures have been practiced orally, they can be produced more readily in written essays and stories. Reading adds another dimension and builds verbal comprehension abilities more directly than any other activity.

## A Relative Weakness in Quantitative Reasoning (Q–)

When compared with students who have an even, or **A,** profile across all three batteries, students who display a relative weakness in quantitative reasoning have somewhat lower levels of achievement on all subtests of the *ITBS,* especially at the primary level. The difference is largest on the Mathematics Concepts, Mathematics Problems, Mathematics Computation, and Language: Usage and Expression tests. A relative weakness in quantitative reasoning abilities generally has a broader impact on the achievement of students than does a relative strength in quantitative reasoning. The connection between lower achievement on the Mathematics Computation and the Language: Usage and Expression tests could reflect a common difficulty in learning rule-based systems or it could reflect a lack of instruction in both areas. Only someone familiar with the students and the emphases of the educational curriculum they have experienced can make this judgment.

The causes of a relative deficit in quantitative reasoning are multiple. Some students have difficulty creating, retaining, and manipulating symbolic representations of all sorts. For some students, this problem seems confined to numerals; for others, however, it stems from a more fundamental difficulty in thinking with abstract, as opposed to concrete, concepts. For example, even the most elementary concepts in mathematics are abstractions. When counting objects, students must recognize that the number 3 in “3 oranges” means the same thing as the number 3 in “3 automobiles.” Students who prefer more concrete modes of thinking can often disguise their failure to think abstractly when using verbal concepts. For example, a child may use the term “dog” appropriately, but may think only about her or his dog when using the term. For other students the difficulty lies in the failure to develop an internal mental model that functions as a number line. For these students, even basic computations such as adding two to a given number must be solved by the application of an algorithm. When performing computations, such students often make substantial errors that they do not detect unless prompted—and even then may not notice. Finally, for some students, the weakness represents nothing more than a lack of experience in talking and thinking about quantitative concepts. This is fairly common in the primary grades. It surfaces again at the secondary level among those who avoid mathematics. At this level, math anxiety can also be a significant issue. As these examples illustrate, successful remediation of a deficit in quantitative reasoning depends on an understanding of the source of the deficit. For students who have difficulty reasoning abstractly, help them focus on and selectively encode the quantitative aspects of a stimulus while ignoring more compelling perceptual features. This selective encoding requires that they be able to ignore context, which can be especially difficult for concrete thinkers.

If students have not established, or cannot readily use a mental model for representing numeric quantities, give them practice in drawing and then trying to envision and use a mental number line to solve basic addition and subtraction problems. Keep in mind that it will take a substantial amount of practice before they will have automatized the use of this first external, then internal, number line so that they can use it when solving a problem.

If the difficulty is lack of experience or the presence of anxiety, then other solutions are required. For reducing anxiety, provide greater structure, reduce or eliminate competition, reduce time pressures, and allow students greater choice in the problems they solve. Experiencing success will gradually reduce anxiety; experiencing failure will cause it to spike to new highs.

As always, help these students discover how to use their better-developed verbal and spatial reasoning abilities for solving mathematical problems. At all grades, but especially in middle school and high school, encourage these students to develop the habit of restating mathematical expressions in words. Encourage them to talk about mathematical concepts rather than simply solving problems silently on work sheets or computer screens. When learning computation skills, they can recite math facts orally and in groups.

Help these students to learn how to exploit their stronger spatial reasoning abilities by encouraging them to create drawings that represent essential aspects of a problem. Show them how drawings can range from concrete depictions of the objects described in the problem to increasingly abstract representations that capture only the essential aspects of the problem. Encourage students to use computers and other tools to offload lower-level computation processes and to focus instead on higher-level concepts. This is often best done using graphic representations of geometric and algebraic concepts.

## A Relative Weakness in Nonverbal Reasoning (N–)

The implications of a relative weakness in nonverbal reasoning are best understood by comparing achievement test scores for such students with the scores of students who have similar levels of verbal and quantitative reasoning abilities but no deficit in nonverbal reasoning. Comparison of these two groups of students shows that, at the primary level, students with a relative weakness in nonverbal reasoning have lower scores on the *ITBS*® Reading, Mathematics Concepts, Mathematics Problems, and Mathematics Computation tests. At the elementary level, these students score lower on the Math Concepts and Estimation, Math Problem Solving and Data Interpretation, and Maps and Diagrams tests. At the secondary level, the deficit is largest on the *ITED*® Analysis of Science Materials test. At all levels, but especially at the primary and secondary levels, these students also have lower composite scores on the achievement test. A deficit in nonverbal reasoning ability has more noticeable and negative consequences for achievement for average-ability students than for students who score in the high (stanines 7–8) or very high (stanine 9) range on *CogAT*.

As with a relative strength in nonverbal reasoning, there are two explanations for a relative weakness in nonverbal reasoning. The first is that the student has difficulty reasoning with figural-spatial stimuli; the second is that the student has difficulty solving unfamiliar problems. For most students, the first explanation is most likely. Fortunately, high levels of spatial reasoning abilities are not required for success in conventionally structured schools. In fact, a relative strength in nonverbal reasoning is often more of a hindrance for students who obtain above-average scores on *CogAT*. However, at least moderate levels of spatial reasoning abilities are required for success in school. Students whose spatial reasoning abilities fall below these levels encounter difficulties in many areas of the curriculum, especially science and mathematics.

Like verbal and quantitative reasoning abilities, spatial reasoning abilities improve with instruction. Therefore, part of the educational planning for students with these score profiles should include training in the specific types of spatial thinking required by the curriculum. This is best done by starting with concrete objects and physical models of concepts used in the curriculum. Then, teach students to draw the model from memory. This same principle works when learning geography. Practice drawing a map of, say, western Europe from memory will result in greater retention of the images than hundreds of trials in which the student merely inspects the map but does not attempt to produce it from memory. In many situations,

however, it will be easier for the student if instruction compensates for, or scaffolds, the student's poor spatial reasoning abilities.

When working with these students, then, watch for signs that they do not understand because they cannot envision the situation or create a model that would represent it. Replace the question "Do you see?" with the more informative "What do you see?" Provide simple drawings that encapsulate the essential features of the visual mental model required by the problem. Give students time to examine the drawing and to label it or coordinate it with the text. When possible, do not require the students to shift their attention between two different locations, such as a drawing displayed on the board or overhead projector and a description of the problem in a textbook or workbook. Keep both in view simultaneously, or allow students to study the visual representation while reading or talking to them rather than requiring that they read the text themselves. Avoid problems that require transformations of images such as imagining how the drawing would appear from another perspective or following a dynamic transformation. Use computer graphics or physical models to display such transformations. This can be especially helpful in mathematics. Allow students to inspect and physically manipulate objects if necessary.

In writing, encourage these students to write narratives rather than descriptions. When teaching strategies, summarize them in short verbal statements that can be rehearsed and committed to memory. When practicing strategies, encourage these students to repeat (aloud) the statements as they perform each step. Follow the same procedure in mathematics. Emphasize strategies that can be summarized verbally. Scaffold visualization by providing drawings, using computer graphs, or having students work in groups in which a partner performs this part of the task.

Finally, rather than indicating a relative weakness in spatial reasoning, the **N–** pattern sometimes indicates a difficulty solving problems unlike like those encountered in school. This interpretation is plausible when there is a systematic decline in performance as the student moves from school-like tasks to unfamiliar tasks. For example, in the verbal domain, the student would perform best on the language subtests of the *ITBS,* somewhat lower on the reading subtests, lower still on the *CogAT* Verbal Battery, and lowest on the *CogAT* Nonverbal Battery. A similar progression could be described in the domain of quantitative reasoning. Additional support for this interpretation may be obtained from observations of the student's study habits and anxiety level. Difficulty in solving novel problems is suggested when students work diligently, even obsessively, at school tasks. Such students often become anxious when placed in situations that lack clear guidelines indicating what they are expected to do or how they will be evaluated.

If the **N–** score pattern seems to reflect these influences rather than a relative deficit in spatial reasoning, the student needs gentle encouragement to engage in discovery learning. The student's problem-solving skills need to be stretched to apply to increasingly unfamiliar, usually less structured situations. Probably the most important guideline here is to stretch gently. Such students can be overwhelmed if the task demands too much insight, creativity, or transfer, or if they perceive criticism rather than encouragement in the feedback they receive. Instead, encourage and reward many small steps away from familiar tasks toward tasks that are not only less familiar, but that are increasingly less structured. This will give the student practice in assembling and reassembling strategies to solve new problems. It will also help the student develop a willingness to attempt the unfamiliar, which is equally important.

# PART 6 Mixed Score Profiles: A Relative Strength and a Relative Weakness

Across all levels of *CogAT,* about one-third of test takers show an even pattern in which all three battery scores are approximately the s**A**me, an **A** profile. About one-half of test takers show uneven profiles in which the score for one battery is a**B**ove or **B**elow the scores for the other two batteries, a **B** profile. The remaining 18 percent of students show profiles in which there is significant **C**ontrast between the scores on two batteries. The general pattern for **C** profiles is one high score (or relative strength), one middle score, and one low score (or relative weakness). Sometimes all three scores differ significantly from one another and sometimes only two scores differ significantly, the high score and the low score. Examination of the plot of the student's score profile shows which scores differ significantly. If the bands around two scores overlap, the scores do not differ significantly from one another.

The achievement test scores of students who show a **C** profile generally fall midway between the scores for the two corresponding **B** profiles. For example, students with the profile **4C (V+ Q–)** show achievement levels that are approximately midway between those shown by the students with **4B (V+)** and **4B (Q–)** profiles. This means that **C** profiles have consequences for achievement test scores that are smaller and less easily summarized than for **B** profiles. It also means that one can gain some insight into a particular **C** profile by reading the discussion of the two corresponding **B** profiles given in Part 7 of the *CogAT Form 6 Interpretive Guide for Teachers and Counselors*.

Students with mixed score profiles are the most difficult to assist with planned interventions. This is because it is often difficult for an observer to know when particular instructional methods or materials capitalize on the students' strengths or, instead, compensate for their weaknesses. For example, students who have difficulty creating and reasoning with visual mental models often perform much better if given a concrete model to work with or a line drawing to look at when attempting to understand a problem. However, if the visual model or graphic is too complex, encoding it requires spatial reasoning abilities. The line between compensation for a weakness and capitalization on a strength is, thus, often difficult to discern in advance. Obviously, these effects differ across students, depending on the complexity of the visual model, the student's familiarity with it, and the level of each student's spatial or figural reasoning abilities.

Teachers who know their students well and who have had experience using particular curricular materials can and often do make good judgments about such matters, especially when a student has an obvious relative strength or weakness in one way of constructing meaning. When a student has both a relative strength and a relative weakness, as in a **C** profile, it becomes very difficult to know how a given intervention will be perceived and processed by the student. Ultimately, decisions about whether a strategy is working as planned must be made by the learners as they try to navigate their way through a lesson, a unit, and, eventually, a course. Therefore, although all learners should be encouraged to develop strategies for regulating their own learning, such self-monitoring and reflectiveness is particularly important for students with mixed patterns of cognitive strengths and weaknesses. It is sometimes useful if students understand the process of learning, using, and then evaluating different strategies as similar to the process of trying on different articles of clothing to see how they fit. It is also important for learners to understand that, like clothing, the strategy that fits best may change as they mature or as the context varies. Because mixed profiles cannot be summarized easily, users should look up particular **C** profiles in Part 7 of the *CogAT Form 6 Interpretive Guide for Teachers and Counselors* or in the Interactive Profile Interpretation System at www.cogat.com.

# PART 7 Where to Get More Information

For additional information on the topics presented in this *Guide,* refer to

Interactive Profile Interpretation System at www.cogat.com

*CogAT Form 6 Interpretive Guide for Teachers and Counselors*

*CogAT Form 6 Interpretive Guide for School Administrators*

*CogAT Form 6 Research Handbook*

For general background on adapting instruction to individual differences, refer to

Stanford Aptitude Seminar (2002). *Remaking the Concept of Aptitude: Extending the Legacy of Richard E. Snow.* Mawhaw, NJ: Erlbaum.